

Map and Sawback Turtle Habitats Potentially Impacted by USACE Reservoir Operations

BACKGROUND: Changing water levels or other operations at U.S. Army Corps of Engineers (USACE) reservoirs may impact critical habitat parameters for map and sawback turtle species. This technical note identifies map and sawback turtle species and habitats potentially impacted by USACE reservoir or other water-control projects as reported by resource managers. Current state and/or Federal legal protection status is summarized and USACE Districts and reservoir projects potentially impacted by map and sawback turtle conservation issues is identified (Table 1). Life-history summaries and habitat requirement descriptions are given for each map or sawback turtle species identified as potentially impacted at reservoir operations. This is a large group of turtles, of which 11 species have either Federal or state protection (Figure 1, Table 2). Six of these species have been associated with environmental issues at 20 USACE projects from 8 USACE Districts (5 USACE Divisions). The 6 turtle species potentially impacted by reservoir operations include 1 Federally protected species, 1 species currently being considered for Federal protection, and 4 species with protection in at least one state. This technical note includes profiles for the six species potentially impacted by reservoir operations



Ringed Sawback Turtle
photo by Dena Dickerson

Distribution of these turtles is species specific. They collectively range throughout U.S. river systems from Ohio, Indiana, Illinois, Wisconsin, Minnesota, and the Dakotas southward to southwestern Alabama and westward to eastern Texas (Figure 2). These turtles prefer waters with moderate to fast currents, abundant basking structures, and wide sandbars. Mollusks and other invertebrates are the primary food items for all species of this group. Basking is an important

Map/Sawback Turtles Potentially Impacted By Reservoir Operations

Turtle Common Name	Scientific Name	Protection Status
Cagle's map	<i>Graptemys caglei</i>	Candidate for Federal protection
False map	<i>G. pseudogeographica</i>	State protected
Ouachita map	<i>G. p. ouachitensis</i>	State possession/harvesting regulations
Map	<i>Graptemys geographica</i>	State protected
Black-knobbed sawback	<i>Graptemys nigrinoda</i>	State protected
Ringed sawback	<i>Graptemys oculifera</i>	Federally threatened

Species	Protection Status		Divisions Identified	Districts Identified	Number	
	State	Federal			District	Total
Cagle's map turtle		Candidate for Federal protection	SWD	Fort Worth	1	1
False map turtle	State protected		LRD NWD MVD	Huntington Omaha Rock Island	2 2 1	5
Map turtle	State protected		MVD	St. Paul	11?	11
Ouchita map turtle	Possession/ harvesting regulations		LRD MVD	Louisville St. Paul	1 11?	12
Black-knobbed sawback turtle	State protected		SAD	Mobile	1	1
Ringed sawback turtle		Federally threatened	MVD	Vicksburg	1?	1
Summary			SWD LRD SAD NWD MVD	Fort Worth Huntington Louisville Mobile Omaha Rock Island St. Paul Vicksburg	1 2 1 1 2 1 11? 1	20

? Questions remain about survey response

component of the daily activity of map and sawback turtles; therefore, the quantity and quality of basking structures will significantly influence their occurrence within a habitat. Population declines for many of these species are directly attributed to habitat destruction and overharvesting for the pet trade.

POINT OF CONTACT: For additional information, contact one of the authors, Ms. Dena D. Dickerson, (601-634-3772, *dickerd@ex1.wes.army.mil*), Mr. Kevin J. Reine, (601-634-3436, *reinek@ex1.wes.army.mil*), or Ms. Kim L. Herrmann, (601-634-3689), or the manager of the Ecosystem Management and Restoration Research Program, Dr. Russell F. Theriot, (601-634-2733), *therior@ex1.wes.army.mil*). This technical note should be cited as follows:

Dickerson, D. D., Reine, K. J., and Herrmann, K. L. (1999). "Map and sawback turtle habitats potentially impacted by USACE reservoir operations," *EMRRP Technical Notes Collection* (TN EMRRP-SI-03), U.S. Army Engineer Research and Development Center, Vicksburg MS. www.wes.army.mil/el/emrrp

April 1999

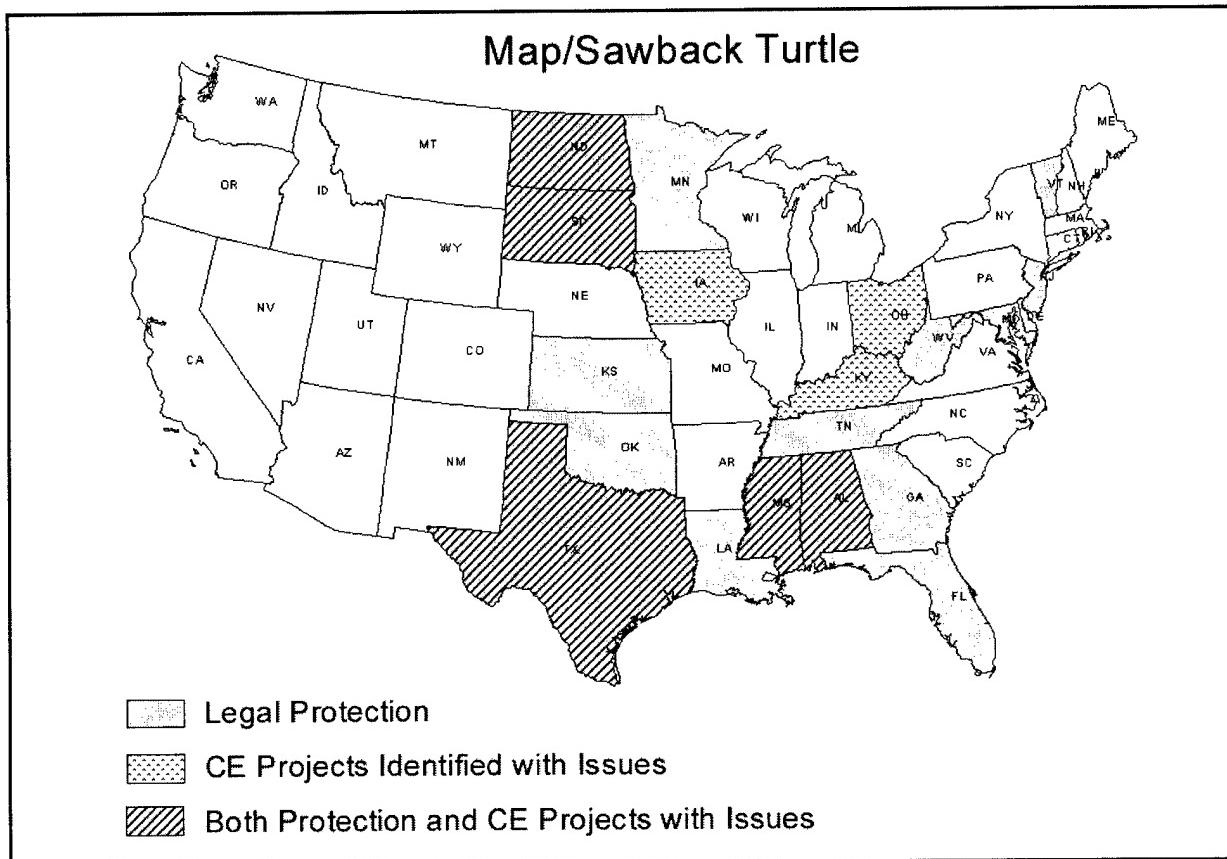


Figure 1. Legal protection status

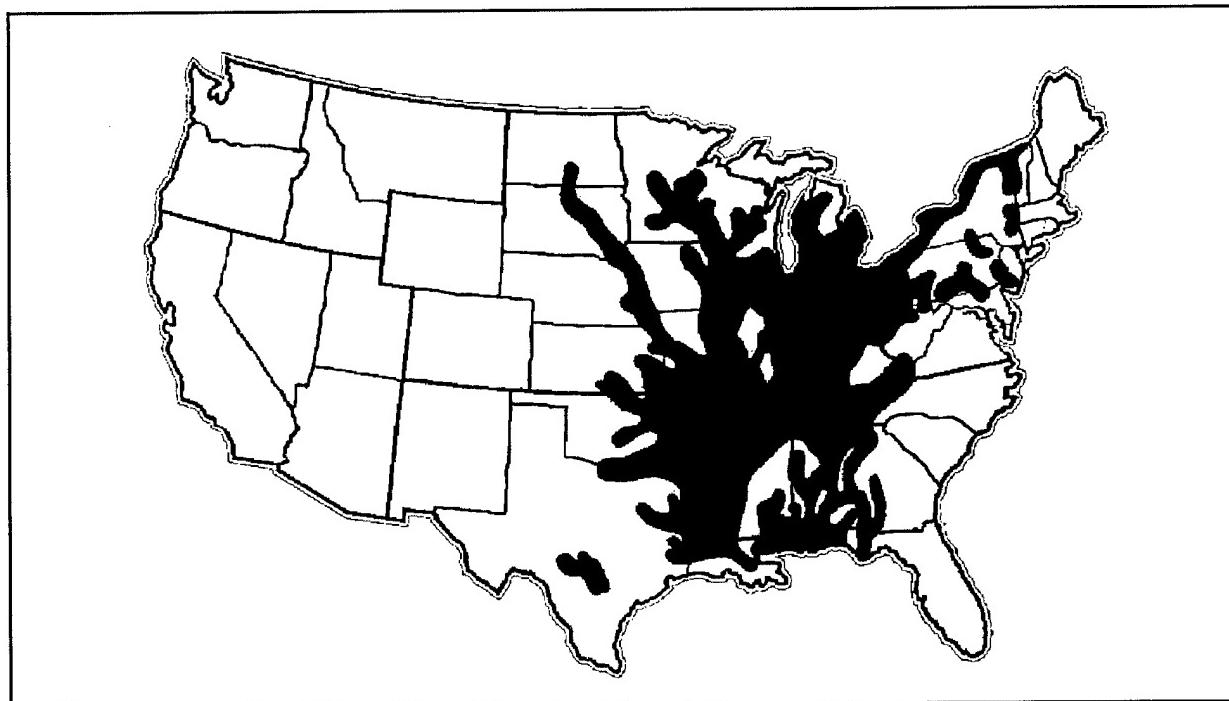


Figure 2. Map/sawback turtle habitat range

Table 2
Turtle Protection Status by Species (Page 1)

States			Cagle's Map	False Map	Map Turtle	Ouachita Map	Black-Knobbed Sawback	Barbour's Map Turtle	Alabama Map Turtle	Ringed Sawback	Yellow-blotched Sawback	Escambia Bay Map Turtle	Sabine Map Turtle
			FC							FT	FT		
Midwest	ID	9/97											
	MT	3/97											
	WY	1/97											
	CO	7/95											
	KS	6/93			T								
	NE	5/94											
	ND	97		SSC									
	SD	3/96		T									
Southwest	NM	12/97											
	AZ	1/97											
	NV	5/94											
	UT	3/97											
Pacific	CA	3/97											
	OR	12/96											
	WA	7/93											
	HI	1/97											
	AK	9/93											
Gulf	TX	11/97	SSC									SSC	
	LA	1/97									FT		
	MS	6/96				E			SSC	E/FT	E/FT		
	AL	11/97						SSC	SSC			SSC	
	OK	4/93			PHR								
	AR	6/96											
	TN	9/94											

FT Federally threatened
FC Federal candidate for protection
SSC State species of special concern
T or ST State threatened

E or SE State endangered
PHR Possession and/or harvesting regulations
Shading Indicates species with potential issues at CE reservoirs

Table 2 (Page 2)

States			Cagle's Map	False Map	Map Turtle	Ouachita Map	Black-Knobbed Sawback	Barbour's Map Turtle	Alabama Map Turtle	Ringed Sawback	Yellow-blotched Sawback	Escambia Bay Map Turtle	Sabine Map Turtle
		FC								FT	FT		
North Central	KY	11/97											
	MO	6/97											
	IA	1/98											
	MN	7/96		PHR	PHR								
	WI	12/97											
	IN	4/97											
	IL	94											
	OH	9/97											
	MI	6/94											
	WV	1/97		PHR	PHR								
North Atlantic	ME	1/95											
	NH	1/98											
	VT	3/98		SSC									
	MA	11/97											
	CT	95											
	RI	95											
	NY	2/97		SSC									
	PA	1/94											
	NJ	6/96											
	DE	3/97											
South Atlantic	MD	11/94		E									
	VA	5/92											
	NC	9/94											
	SC	1/98											
	GA	10/97		SSC			T	SSC					
	FL	8/97					SSC				PHR		

Profile: Cagle's map turtle (*Graptemys caglei*)

Distribution. Cagle's map turtle has a limited distribution; the southernmost of any *Graptemys* species. This species is restricted to the Guadalupe and San Antonio River watersheds of south-central Texas, but may now be extirpated in the San Antonio drainage.

Habitat. Habitat in the Guadalupe River system consists of limestone- or mud-bottomed streams with moderate current, and numerous pools of varying depths. In addition, it may be found in slow-moving water, 1-3 m deep, behind impoundments (Vermersch 1992).

Behavior. Cagle's map turtle is diurnal and spends much of its time basking on logs, rocks, and cypress knees. Haynes and McKown (1974) observed that logs that had fallen into the river, but were still connected to the bank, were not used as basking structures by Cagle's map turtle. Similar to other map turtles, this species is wary and difficult to approach. With the exception of nesting, this species rarely comes onto land (Vermersch 1992).

Reproduction. Limited biological data exist on this species. Haynes and McKown (1974) observed and collected hatchlings from September through November, indicating a late spring to early summer nesting season. As many as three clutches may be laid yearly containing one to six eggs (Vermersch 1992). Eggs are deposited in nests located near the water in cavities approximately 15 cm deep. Gender development is temperature-dependent, with high incubation temperatures producing only females and low temperatures producing only males (100 percent males at $\leq 28^{\circ}\text{C}$; 100 percent females at 30.5°C) (Wibbels et al. 1991). The estimated pivotal temperature (approximately 30.0°C) is higher than those reported for other species of *Graptemys* in North America.

Food Habits. Adults primarily feed on insects (caddisfly larvae and larval cases) and snails, and may incidentally ingest algae and plant matter such as bark. The diet of juveniles consists of small gnat-like insects with incidental pieces of bark and grass (Haynes and McKown 1974).

Populations. This turtle is the dominant turtle in certain parts of the Guadalupe watershed (Vermersch 1992).

Remarks. *Protection Status:* Federal: Candidate for Federal protection; State species of special concern: Texas.

Profile: False map turtle (*Graptemys pseudogeographica*)

Distribution. Found primarily in large streams of the Missouri and Mississippi River systems from Ohio, Indiana, Illinois, Wisconsin, Minnesota, and the Dakotas southward; possible to extreme southwestern Alabama, southern and western Mississippi, Louisiana, and eastern Texas.

Habitat. Typically found in large rivers and their backwaters, but also occupies lakes, ponds, sloughs, bayous, oxbows, and occasionally marshes. The false map turtle prefers water with abundant aquatic vegetation, places to bask, and slow currents, but can be found in swiftly flowing channels of large rivers.

Behavior. Activity varies geographically, but generally ranges from late March to mid-October (Johnson 1983). Emergence from overwintering (observed in Wisconsin) occurs in April when water temperatures are 4-7 °C (Vogt 1980). Overwintering sites typically include muskrat lodges or bank burrows. It is not uncommon for the false map turtle to be seen basking during winter days in its more southerly range. It spends the majority of its day basking (from 0900 to 1800 hr) on muskrat lodges, logs, rock piles, sandbars, or stumps. Basking rarely occurs on or near shore. Basking turtles stretch their hind limbs, spread the webbing between the toes, and extend the head and forelimbs. Basking turtles are extremely wary and difficult to approach. Entrance into the water by one turtle is usually followed by all those basking in the general vicinity. Movement data of this turtle is sparse. In summer months, most males move into quiet backwaters to forage. Females also move into backwaters to forage after laying their first clutch of eggs (Vogt 1980).

Reproduction. Mating (data obtained from one study in Wisconsin) probably occurs in April and again in October and November (Vogt 1980) but has been observed in a captive male in July (Ernst 1974). The nesting season (Wisconsin) lasts from mid-May to late July. First clutches are usually laid by mid-May to mid-June (Vogt 1980). Nest construction occurs from 0545 and 2030 hr; however, most clutches are deposited from 0630 to 1000 hr on overcast days. Nests are located in open sand areas or in areas dominated by low shrubs. Nests are flask-shaped and dug with the hind limbs. Two and possibly three clutches, from 8-22 eggs (varies with subspecies), are laid per year. Natural incubation lasts from 60 to 82 days (Ewert 1979a). Gender determination correlates with incubation temperature (males at ≤ 25 °C; females at ≥ 30 °C).

Food Habits. The false map turtle is omnivorous, feeding on mollusks, insects (e.g., mayfly and damselfly larvae), and plant material (*Vallisneria*, *Potamogeton*, and *Lemna*). In addition to consuming the same insects as females, males eat beetles, flies, and fish carrion (Vogt 1981a, 1981b). In its southern range, mollusks are the principal component of the diet.

Populations. Declining populations in Missouri are attributed to several factors, including water pollution, river channelization, reduction of suitable nesting sites, siltation, and unlawful shooting (Johnson 1983). In the past, the pet trade has also influenced population stability. Commercial fishermen reported that the species was more abundant 25 years earlier in the Missouri and Mississippi Rivers, but has now become uncommon and all but eradicated for several river miles below Kansas City and St. Louis. They attributed this decline to water pollution.

Remarks. Protection Status: Threatened: South Dakota; State species of special concern: North Dakota.

Profile: Ouachita map turtle (*Graptemys ouachitensis*)

Distribution. The Ouachita map turtle range extends from Texas and Louisiana north and eastward to eastern Kansas, eastern Iowa, Minnesota, Wisconsin, Illinois, Indiana, Kentucky, Tennessee, and northern Alabama. A population, separated from the main range by 200 km, exists in two counties in Kansas (Mitchell and Pawnee Counties) and in south-central Ohio.

Habitat. The Ouachita map turtle is primarily riverine, inhabiting areas with swift currents and submerged vegetation (Harvey 1992). It can also be found in impoundments, lakes, oxbows, and river-bottom swamps. Sand and silt bottoms are preferred over those of gravel, stone, or mud (Ewert 1979b). Density is influenced by a number of factors, including the amount of algal growth on logs and basking sites available; however, stream width is the primary factor restricting the upstream limit of distribution.

Behavior. Behavior of the Ouachita map turtle is similar to *Graptemys pseudogeographica* with several important differences. In Wisconsin, where the two species are sympatric, male *G. ouachitensis* remain in river channels during the summer but *G. pseudogeographica* move into quiet backwaters to forage. Female *G. ouachitensis* move to patches of vegetation adjacent to sloughs or river channels after laying their second clutch (Vogt 1980). Both species spend the majority of the day basking during the active season, and are frequently seen basking in large groups (Lovich et al. 1990). Very little is known about the ecology and behavior of this species in the southern part of its range.

Reproduction. Studies conducted in Wisconsin by Vogt (1980) observed courtship and mating in April, October, and November. These studies indicated the nesting season begins in mid-May and lasts until late July, with the first clutch of the season laid from mid-May to mid-June. Nests are constructed between 0545-2030 hr, but peak activity occurs between 0630-1000 hr. Nesting occurs throughout the day on overcast days, but is interrupted by rain. Nest locations and nest construction are similar to *G. pseudogeographica*. Two and possibly three clutches are laid per year in Oklahoma and Wisconsin (Vogt 1980). Clutch sizes have a mean range of 6 to 15 eggs, with an overall mean clutch size of 10.5. Overwintering in the nest by hatchlings is not common (Ernst et al. 1994). Incubation lasts from 60-82 days. Gender is correlated with incubation temperature. Eggs incubated at 28 °C produce 100 percent males, whereas eggs incubated at 30 °C produce almost no males (Ewert and Nelson 1991).

Food Habits. The Ouachita map turtle is omnivorous, with females feeding on mollusks, insects (caddisfly cases, mayfly larvae, and damselfly larvae), and plant material (e.g., *Vallisneria*, *Potamogeton*, *Lemna*). Males eat the same insects as females, as well as beetles, flies, mollusks, fish carrion, and trace amounts of vegetation. The relatively narrow crushing surfaces of its jaws probably prevent this species from feeding predominantly on mollusks. Feeding begins in late May and continues until mid-September (Vogt 1980).

Populations. Some studies have shown a large female-biased sex ratio (3:1), which may be due to either the effects of temperature-dependent gender determination or to sampling bias (Shively and Jackson 1985).

Remarks. *Protection Status:* Possession and/or harvesting regulations: West Virginia.

Profile: Common map turtle (*Graptemys geographica*)

Distribution. The common map turtle range extends from southern Quebec and northwestern Vermont in the St. Lawrence drainage west through the Great Lakes into southern Wisconsin and eastern Minnesota, and west of the Appalachians, south to Kansas, northeastern Oklahoma, Arkansas, Tennessee, Alabama (above the fall line) and northwestern Georgia. It also occurs in the Susquehanna River system of Pennsylvania and Maryland and in the Delaware River of Pennsylvania and New Jersey (Arndt and Potter 1973). An isolated population exists in the Hudson River. This is the only species of map turtle that inhabits watersheds emptying into the Atlantic Ocean (Ernst et al. 1994).

Habitat. This species is typically found in large bodies of water such as rivers and lakes, especially in areas with abundant basking sites. Some studies indicate that capture rates were higher in deep, slow-moving waters (53 percent) as compared to shallow areas, which were the least preferred (2.3 percent) (Ernst et al. 1994). Large turtles were captured in deep, slow-moving waters and small turtles in shallow, slow-moving waters. Large adults avoided areas with emergent vegetation, but congregated in areas with fallen limbs (Pluto and Bellis 1986).

Behavior. The common map turtle is primarily diurnal, foraging in the morning and late afternoon and basking at midday. Turtles generally become active from April to late October or early November during warmer years, but may become inactive in late September if the weather turns cold (Vogt 1980). Females begin to bask in April soon after emerging in preparation for reproduction. Basking in some locations (e.g. Quebec) is bimodal, with peaks in May-June and August (Gordon and McCulloch 1980). Large numbers of turtles will bask together at the same site. Large turtles will frequently push smaller turtles off the basking log. Map turtles are extremely wary while basking and are difficult to approach.

Reproduction. Little information exists regarding the attainment of sexual maturity by this turtle. Courtship and mating occur both in spring and autumn. The nesting period varies geographically but usually lasts from late May to mid-July with a peak during the second and third weeks of June. Nest sites are characterized as having soft soil or sand and full sunshine and are generally located near water (~3 m). The majority of nesting occurs early in the morning before 0800 hr. Clutch size varies from 9-17 eggs (Gordon and McCulloch 1980). Two or three clutches are laid each year. Hatchlings either emerge from the nest in August/September or overwinter depending on locality (Gibbons and Nelson 1978). Gender is temperature-dependent, with a majority of males being produced at 25 °C, while 30 °C produces mostly females.

Food Habits. The diet of the common map turtle varies geographically. Over 90 percent of turtles examined in the Niangua River, Missouri, had diets consisting of the small snail *Elimia potosiensis* (White and Moll 1991). In Wisconsin, the common map turtle diet consisted mostly of mollusks (Vogt 1981b). Other food items consisted of crayfish, clams, water mites, insects (e.g., caddisflies, mayflies, damselflies), fish, and plant material.

Populations. Populations may be substantial in waterways with abundant mollusks. Mature males outnumber mature females (Pluto and Bellis 1986). Male-to-female sex ratios have been reported at 1.2:1 for a section of the Pennsylvania River and 1.67:1 in a Quebec lake (Gordon and McCulloch 1980). Juvenile to adult ratios were reported as 0.06:1 and 0.024:1 for the same studies, respectively.

Remarks. Protection Status: Endangered: Maryland; Threatened: Kansas; State species of special concern: Vermont, New Jersey, Georgia; Possession and/or harvesting regulations: West Virginia, Oklahoma.

Profile: Black-knobbed map turtle (*Graptemys nigrinoda*)

Distribution. The black-knobbed map turtle range extends below the fall line in the Alabama, Tombigbee, Black Warrior, Coosa, Tallapoosa, and Cahaba Rivers of Alabama and Mississippi (Cliburn 1971).

Habitat. This turtle species is often found in sand and clay-bottomed streams with moderate currents and abundant basking sites of brush, logs, and debris. At these sites, this species is found in deeper waters than either *G. oculifera* or *G. flavimaculata*.

Behavior. Basking behavior is well-developed and basking may occur in any month of the year, but the species is not active at water temperatures under 10 °C. Optimal basking conditions occur at water temperatures higher than 15 °C and air temperatures higher than 20 °C during periods of time with little or no rainfall (Waters 1974). Individual turtles have basking-site fidelity. Preferred basking sites include stationary logs or a tangle of logs separated from the shoreline by an area of open water. Turtles frequently bask together with members of their own species as well as other species (as many as four other species have been observed) with no observed aggressive interactions (Waters 1974). This map turtle spends the night sleeping on brush piles and logs. It seldom leaves the water except to bask or lay eggs.

Reproduction. Little is known about the reproductive biology of this turtle. The information presented is from a study conducted by Lahanas (1982) on the Tensaw River (Gravine Island) on the subspecies *Graptemys nigrinoda delticola*. Neither courtship nor mating have been observed under natural conditions. The nesting season (Gravine Island) begins in late May, peaks from mid-June to mid-July, and ends in early August. The nesting season is approximately 72 days long. Peak nesting activity occurs between 2100-2400 hr. Nests are generally located within 50 m of the waterline in open sunny areas with widely separated clumps of short grass. The majority of nests are constructed in fine quartz sand with no organic matter. Before actual construction of the nest occurs, prenesting activities (including wandering, test scratch, and test nest construction) are completed. Nest construction (completion time: 16-34 min) involves alternate scraping with the hind limbs while pivoting the body from side to side as each limb is inserted into the cavity. Lahanas (1982) suggests that as many as 3 to 4 clutches (clutch size 3-8 eggs, $\bar{x} = 5.5$) could be laid per year. Lahanas (1982) observed clutches incubated under both natural and artificial conditions and reported the incubation period to range from 60-68 days with an average incubation period of 62.9 days. Overwintering in the nest has not been observed.

Food Habits. Both Wahlquist (1970) and Mount (1975) observed *G. nigrinoda* eating beetles and dragonflies that had fallen into the water. A more detailed study of food habits was conducted by Lahanas (1982), who reported primary food items consisting of sessile organisms such as mollusks, blue crabs, barnacles, bryozoans, sponges, and freshwater algae. Both sexes consume the same food items, but in different proportions. A clear relationship has been identified between the size of the turtle and the size of mollusks consumed, with larger turtles eating larger mollusks.

Populations. Past studies (1953-1955) indicated that this species accounted for 40 to 70 percent of turtles collected in the Tombigbee River (Tingle 1959). Lahanas (1982) reported that this species accounted for approximately 42 percent of the turtles captured in the Tensaw River, Alabama (Gravine Island).

Remarks. Protection Status: Endangered: Mississippi.

Profile: Ringed sawback turtle (*Graptemys oculifera*)

Distribution. The ringed sawback turtle is restricted to the Pearl River and its major tributaries in Mississippi and Louisiana; however, it is not found in the tidally influenced lowermost section of the West Pearl River (McCoy and Vogt 1988; Dickerson and Reine 1996).

Habitat. Preferred habitat includes wide rivers with strong currents, adjacent white sand beaches, and an abundance of basking sites in the form of brush, logs, and debris.

Behavior. Limited data have been published regarding the life history of the ringed sawback turtle. Basking is an important component of the daily activity of this species. While basking, this species is wary and difficult to approach. Basking sites are often shared with other turtles, including: *G. gibbonsi*, *G. pseudogeographica kohnii*, *Trachemys scripta*, *Pseudemys concinna*, *P. floridana*, *Sternotherus carinatus*, *Trionyx muticus*, and *T. spiniferus*. When basking in groups, turtles seldom orient in the same direction. This behavior provides the group with all-round visibility (Gordon and MacCulloch 1980). When one turtle is disturbed and enters the water, the others quickly follow. Nighttime is spent resting on branches and snags just below the water. Hatchlings leave the nest within 3 hr after sunset, the only time they are known to be nocturnally active (Anderson 1958).

Reproduction. Courtship and mating behavior has not been described for the ringed sawback turtle. Eggs are deposited on sandbars in early June (Cagle 1953). Jones (1991) found nests 7.0-17.4 m from the edge of the water and 0.06-3.5 m from the nearest vegetation. Under laboratory conditions, eggs hatch in an average of 62.8 days.

Food Habits. Both Dundee and Rossman (1989), and Kofron (1991) examined the stomach contents of ringed sawback turtles. Insects and plant material (algae) accounted for the bulk of the diet, including: adult and larval caddisflies, dipteran flies and mayflies, damselflies, dragonfly nymphs, beetles, and chironomid fly larvae. Other food items included snails, small nematodes, and earthworms. These studies reported no difference between adult and juvenile stomach contents.

Populations. Density and population structure were assessed by Jones (1991) and Dickerson and Reine (1996). Population density estimates for Ratliff Ferry (Pearl River, Jackson, Mississippi) produced a range of 366 to 1107 *G. oculifera* per river kilometer (Dickerson and Reine 1996). Two mark-recapture methods used by Jones and Hartfield (1995) produced independent density estimates of 341 and 1170 *G. oculifera* per river kilometer. Highest densities are documented above the Ross Barnett Reservoir and below the Jackson, Mississippi, metropolitan area (Jones and Hartfield 1995). Lower densities have been reported for Monticello, Mississippi, due to papermill effluents, and Jackson and Terry, Hinds County, Mississippi, where the river is severely polluted from Jackson sewage and industrial waste (McCoy and Vogt 1980; Jones and Hartfield 1995). Habitat modification and water quality degradation are the most often cited reasons for declining numbers of ringed sawbacks (McCoy and Vogt 1980; Stewart 1988). Comparisons between the relative abundance of *G. oculifera* in the upper Pearl River (Mississippi) and sites examined in sections of the West Pearl River (Louisiana) show markedly lower densities in the West Pearl River. Density estimates for sections of the West Pearl River ranged from 0 to 209 turtles per river kilometer (Dickerson and Reine 1996).

Remarks. Protection Status: Federally threatened: Louisiana, Mississippi; Endangered: Mississippi.

REFERENCES

- Anderson, P. K. (1958). "The photic responses and water-approach behavior of hatchling turtles," *Copeia* 1958:211-15.
- Arndt, R. G., and Potter, W. A. (1973). "A population of the map turtle, *Graptemys geographica*, in the Delaware River, Pennsylvania," *Journal of Herpetology* 7:375-77.
- Cagle, F. R. (1953). "The status of the turtle *Graptemys oculifera* (Baur)," *Zoologica* 38:137-44.
- Cliburn, J. W. (1971). "The ranges of four species of *Graptemys* in Mississippi," *Journal of Mississippi Academy of Science* 16:16-19.
- Dickerson, D. D., and Reine, K. J. (1996). "Habitat assessment and relative abundance estimates for the ringed sawback turtle (*Graptemys oculifera*) in dredging sites of the west Pearl River navigation project (Louisiana)," Project report for the U.S. Army Corps of Engineers, Vicksburg District, by the U.S. Army Corps of Engineers Waterways Experiment Station, Environmental Laboratory, Vicksburg, MS.
- Dundee, H. A., and Rossman, D. A. (1989). *The amphibians and reptiles of Louisiana*. Louisiana State University Press, Baton Rouge, LA.
- Ernst, C. H. (1974). "Observations on the courtship of male *Graptemys pseudogeographica*," *Journal of Herpetology* 8:377-78.
- Ernst, C. H., Lovich, J. E., and Barbour, R. W. (1994). "Turtles of the United States and Canada," N. P. Dutro, ed., Smithsonian Institution.
- Ewert, M. A. (1979a). "The embryo and its egg: Development and natural history," *Turtles: Perspectives and research*, M. Harless and H. Morlock, eds., John Wiley & Sons, New York, 333-413.
- Ewert, M. A. (1979b). "*Graptemys pseudogeographica ouachitensis* (Ouachita map turtle). USA: Indiana," *Herpetological Review* 10:102.
- Ewert, M. A., and Nelson, C. E. (1991). "Sex determination in turtles: Diverse patterns and some possible adaptive values," *Copeia* 1991:50-69.
- Gibbons, J. W., and Nelson, D. H. (1978). "The evolutionary significance of delayed emergence from the nest by hatchlings turtles," *Evolution* 32:297-303.
- Gordon, D. M., and MacCulloch, R. D. (1980). "An investigation of the ecology of the map turtle, *Graptemys geographica* (LeSueur), in the northern part of its range," *Canadian Journal of Zoology* 58:210-19.
- Harvey, M. B. (1992). "The distribution of *Graptemys pseudogeographica* on the upper Sabine River," *Texas Journal of Science* 44:257-58.
- Haynes, D., and McKown, R. R. (1974). "A new species of map turtle (genus *Graptemys*) from the Guadalupe River system in Texas," *Tulane Studies in Zoology and Botany* 18:143-52.
- Johnson, K. A. (1983). "The decline of the spotted turtle, *Clemmys guttata*, in northeastern Illinois," *Bulletin of Chicago Herpetological Society* 18:37-41.
- Jones, R. L. (1991). "Density and population structure of the ringed sawback turtle, *Graptemys oculifera* (Baur)," Final Report. Mississippi Department of Wildlife and Fisheries Parks, Museum of Natural Science, Museum Technical Report (17):1-55.
- Jones, R. L., and Hartfield, P. D. (1995). "Population size and growth in the turtle *Graptemys oculifera*," *Journal of Herpetology* 29(3):426-36.
- Kofron, C. P. (1991). "Aspects of ecology of the threatened ringed sawback turtle, *Graptemys oculifera*," *Amphibia-Reptilia* 12:161-68.
- Lahanas, P. N. (1982). "Aspects of the life history of the southern black-knobbed sawback, *Graptemys nigrinoda delticola* Folkerts and Mount," M.S. thesis, Auburn University, Auburn, AL.

- Lovich, J. E., Garstka, W. R., and McCoy, C. J. (1990). "The development and significance of melanism in the slider turtle," *Life history and ecology of the slider turtle*, J. W. Gibbons, ed., Smithsonian Institution Press, Washington, DC, 233-54.
- McCoy, C. J., and Vogt, R. C. (1980). "Distribution and population status of the ringed sawback *Graptemys oculifera* (Baur) in Mississippi and Louisiana," Final Report, U.S. Fish and Wildlife Service, Contract No. 14-16-004-79-038.
- McCoy, C. J., and Vogt, R. C. (1988). "*Graptemys oculifera*," Catalog American Amphibian Report 484:1-2.
- Mount, R. H. (1975). "The reptiles and amphibians of Alabama," Auburn University Agricultural Experiment Station, Auburn, AL.
- Pluto, T. G., and Bellis, E. D. (1986). "Habitat utilization by the turtle, *Graptemys geographica*, along a river," *Journal of Herpetology* 20:22-31.
- Shively, S. H., and Jackson, J. F. (1985). "Factors limiting the upstream distribution of the Sabine map turtle," *American Midland Naturalist* 114:292-303.
- Stewart, J. H. (1988). "A recovery plan for the ringed sawback turtle *Graptemys oculifera*," U.S. Fish and Wildlife Service, Southeast Region.
- Tingle, D. W. (1959). "The relation of the fall line to the distribution and abundance of turtles," *Copeia* 1959:167-70.
- Vermersch, T. G. (1992). "Lizards and turtles of south-central Texas," Eakin Press, Austin, TX.
- Vogt, R. C. (1980). "Natural history of the map turtles *Graptemys pseudogeographica* and *G. ouachitensis* in Wisconsin," *Tulane Studies in Zoology and Botany* 22:17-48.
- Vogt, R. C. (1981a). "Natural history of amphibians and reptiles of Wisconsin," Milwaukee Public Museum, Milwaukee, WI.
- Vogt, R. C. (1981b). "Food partitioning in three sympatric species of map turtles, genus *Graptemys* (Testudinata, Emydidae)," *American Midland Naturalist* 105:102-11.
- Wahlquist, H. (1970). "Sawbacks of the Gulf Coast," *International Turtle and Tortoise Society Journal* 4(4):10-13.
- Waters, J. H. (1974). "The biological significance of the basking habit in the black-knobbed sawback, *Graptemys nigrinoda* Cagle," M.S. thesis, Auburn University, Auburn, AL.
- White, C. P., and Moll, D. (1991). "Clutch size and annual reproductive potential of the turtle *Graptemys geographica* in a Missouri stream," *Journal of Herpetology* 25:493-94.
- Wibbels, T., Bull, J. J., and Crews, D. (1991). "Chronology and morphology of temperature-dependent sex determination," *Journal of Experimental Zoology* 260:371-81.